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Original Research Article

To Evaluate the Role of Comorbidities in the Development of Acute Kidney Injury in Intensive Care Patients at a Tertiary Care Hospital in Bangladesh

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Abstract: ***Background:*** Indeed, AKI is a common complication in ICU patients, and it is associated with an increase in morbidity and mortality as well as healthcare costs. Recognizing AKI risk factors in LMIC settings is important for intervention approaches. ***Objectives:*** The objectives of this study are as follows: To determine the incidence of AKI based on RIFLE criteria among the critically ill patients in a tertiary care hospital in Bangladesh and to analyze the impact of the presence of comorbidities on the development of AKI in these patients. ***Methods:*** This prospective observational study was carried out at the ICU of Community Based Medical College in Bangladesh from January to December 2023. The target subjects were adult patients who were admitted to the ICU for a period of 24 to 48 hours. Patients with AKI were categorized using RIFLE criteria based on serum creatinine and urine output. For the univariate and multivariate logistic regression, demographic data, comorbidities, and clinical characteristics were collected. ***Results:*** In the present study of 22 patients with a mean age of 42.16 years and 63.6% of male patients, 86.4 percent of the patients had AKI according to both serum creatinine and urine output criteria. Sepsis/septic shock ([OR] 2. 2, [CI] 0. 8–5. 8) and cardiac etiology ([OR] 2. 7, [CI] 1. 0–7.1) were significant predictors of AKI. The study revealed that respiratory disease [OR. = 3.56, 95% confidence interval (CI): 0.33–38.78] and hematologic malignancy [OR. = 4.20, 95% CI: 0.40–43.82] were the comorbid conditions most closely associated with AKI. ***Conclusions:*** This research shows a very high prevalence rate of AKI among the clients in critical conditions in Bangladesh. Sepsis, cardiac dysfunction, respiratory disease, and hematologic malignancies emerged as significant factors. The results are therefore informative for programs aimed at improving AKI awareness, early detection activities, and prevention efforts in low-resource settings.

Keywords: Comorbidities, Acute kidney injury (AKI), Intensive care units (ICU).

INTRODUCTION

It is a known fact that AKI is a major problem in the ICU, making a significant contribution to morbidity, mortality, and increased health-care costs. It has been estimated that the AKI affects between 20 and 50 percent of patients admitted to intensive care units, depending on the criteria used and the cohort of patients being studied [1]. As such, we argue for more consistent measure framing and enhanced insight into risk antecedents across different healthcare contexts. The RIFLE (Risk, Injury, Failure, Loss, End-stage renal disease) criteria have been newly developed as an important means for defining and staging AKI. RIFLE is based on changes in serum creatinine and urine output in order to classify AKI severity [2]. This classification system has shown excellent reliability and validity indices in various studies, showing significant correlation with clinical indices, and has been widely used in research as well as clinical settings. In critical patient settings, such as ICU patients, AKI is often presented in a setting of multi-organ dysfunction. Sepsis is identified as the commonest contributor to AKI in intensive care units in the studies reviewed. However, the role of the other comorbidities in AKI development has not been established with the same clarity [3]. Some AKI

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risk factors involve cardiovascular disease, chronic kidney disease, diabetes, and immunosuppression, with heterogeneous outcomes regarding the correlation with AKI across various patient groups and healthcare settings. Specifically, understanding the risk factors for AKI and the outcomes among individuals in LMIC is fairly uncharted territory. Different patterns of AKI may emerge from our study given the context of Bangladesh, which is a developing country with access to only basic healthcare and a high burden of both infectious and non-infectious diseases. Such generalizations are important, particularly when designing preventive measures and applying available resources in resource-poor environments [4]. It has been established that appropriate identification of AKI and its subsequent treatment play a huge role in enhanced prognosis [5]. Nevertheless, it has been quite challenging to pinpoint high-risk patients accurately, and this is even more so when it comes to diverse healthcare systems. This challenge is further exacerbated by the differences that may exist in the incidence and risk factors of AKI between HIC and LMIC [6]. Based on these aspects, the present prospective observational study was formulated to determine the prevalence of AKI by employing RIFLE criteria and to assess the impact of comorbidities on AKI development among critically ill patients in a tertiary care hospital in Bangladesh. The study aims to comprehensively address several critical objectives: testing the applicability of the RIFLE criteria in estimating the prevalence and severity of AKI in ICU patients; identifying the main causes and risk factors for AKI in this population; investigating the relationship between pre-existing comorbidities and the development of AKI; and comparing the demographic and clinical characteristics of the patients who develop AKI [7].

In order to achieve these objectives, this research aims to gather important information on the prevalence of AKI among Bangladeshi ICU patients. Such information is crucial in the sense that prevention programs can then be designed to provide support to high-risk populations [8]. Consequently, the research can help identify best practices necessary for formulating the local clinical practice guidelines for critically ill patients in Bangladesh and advise on the allocation of the available resources in the course of decreasing the AKI impa [9] ct. These findings may enhance the understanding of AKI on various continents and thus the variability between high- and low-income countries. This knowledge is important for advancing better targeted, context-adapted preventive and therapeutic measures for AKI in the global intensive care unit.

MATERIALS AND METHODS

This prospective non-interventional study was done in the Department of Nephrology and Intensive Care Unit, Community Based Medical College, Bangladesh, from January to December 2023.

Inclusion and Exclusion Criteria:

- Patients that were >18 years of age and had been admitted in the ICU for 24 hours down to 48 hours were considered for the study.
- Patients in the pre-dialysis stage of end-stage renal disease who were receiving dialysis were also excluded from the study.

This research complies with the principles of ethical research: the study received approval from the institutional ethics committee; patients or their legally authorized representative signed an informed consent form.

Operational Definitions

In the study of acute kidney injury (AKI), the RIFLE criteria were adopted and applied to classify AKI. This classification system includes three severity levels: The three primary elements one is likely to encounter are risk, injury, and failure [10]. Risk is defined as an increase in serum creatinine by 5-2 fold from baseline or a urine output less than 0. They received a rate of 5 mL/kg/h for the first six hours of the treatment. For injury, there has to be a rise in the serum creatinine level by 2-3 times its normal or urine output of 0.

However, if the patient's condition is severe, then a rate of 5 mL/kg/h for 12 hours is appropriate. Failure, the worst of all stages, is characterized by a more than three-time increase in serum creatinine levels (a level of serum creatinine of ≥ 4 mg/dL with an acute rise of at least 0.5 mL/hour) or electrolyte abnormalities such as hypokalemia or hypocalcemia that have worsened since the last dose of LASIK. 3 mL/kg/h for 24 hours or a significant decrease in urine output for 12 consecutive hours. Special emphasis was made to identify the worst RIFLE category attained within the first week of admission to the ICU [11]. Pre-admission creatinine by gradient enhancement was defined as the lowest serum creatinine in three months before admission or calculated based on the MDRD formula when the data was not available. Comorbid illnesses were defined as those identified based on documented history at the time of enrollment through chart abstraction among patients with cardiovascular disease (hypertension, coronary artery diseases [CAD], congestive heart failure), immunocompromised status (human immunodeficiency virus [HIV] infection, immunosuppressive medication use, active malignancy), respiratory disease (chronic obstructive pulmonary disease [COPD], interstitial lung disease), and cancer. AKI was initially classified according to the primary cause as defined by Morrissey and colleagues, based on clinical data and chart review by treating physicians [12].

Data Analysis

Patient demographics and clinical characteristics were described using summary statistics. Thus, univariate and multivariate logistic regression analyses were conducted to test hypotheses regarding predictors of AKI.05, which were deemed to be statistically significant. Statistical analysis was done using the Statistical Package for Social Science (IBM SPSS Statistics for Windows, Version 25.0).

RESULTS

A total of 22 patients with critical illnesses were recruited in this cross-sectional study conducted within the ICU. The demographic analysis revealed that the mean age among the respondents was 42, who were 89 years old on average, and of whom 68.2% were in the 41–50 age range. Of all the patients that were recorded, male patients were predominant, accounting for 63 percent. 9% were non-married, 27% widow / widower, 21. As for the occupation, the women with no occupation constituted the largest segment (40.9%); the second most populated segment was service holders (31.8%) (Table 1).

Table1: Demographic characteristics of the study participant (N=22)

Age in year	Frequency (N)	Percentage (%)
30-40	7	31.8%
41-50	15	68.2%
Mean±SD	42.16±4.89	
Gender		
Male	14	63.6%
Female	8	36.4%
Marital Status		
Married	6	27.3%
Divorced	4	18.2%
Unmarried	9	40.9%
Widow	3	13.6%
Occupation		
Housewife	9	40.9%
Unemployed	6	27.3%
Service Holder	7	31.8%

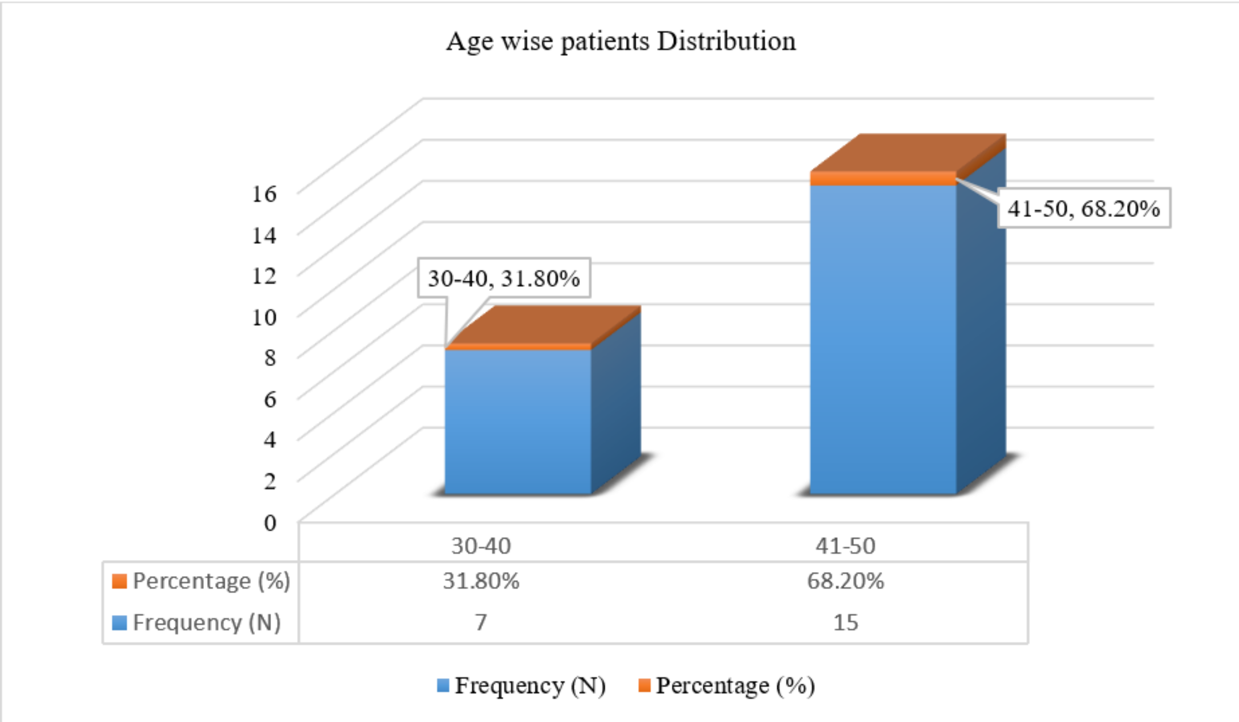

Figure I: Bar chart showed distribution of the patients by age (N=22)

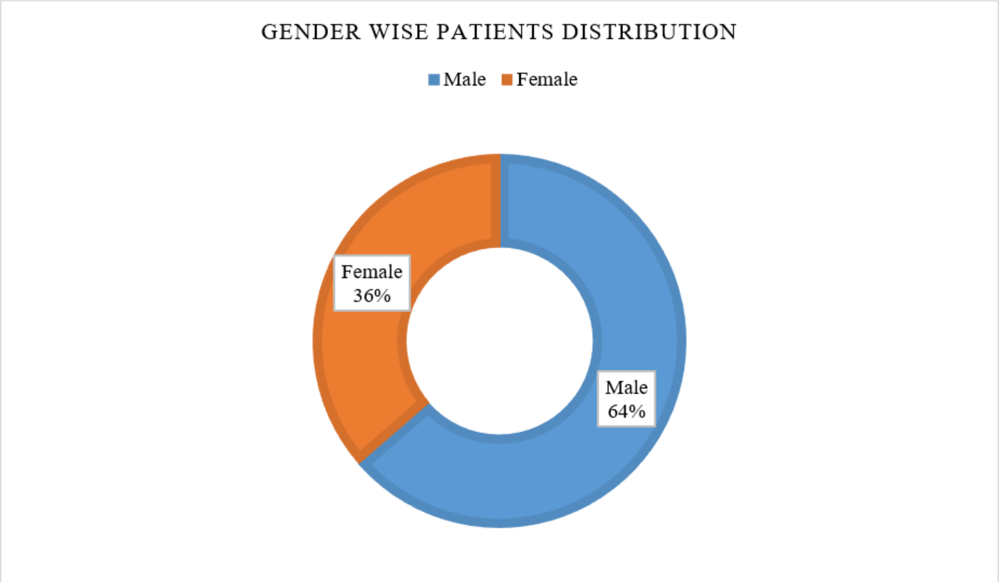

Figure II: Pie chart showed distribution of the patients by Gender (N=22)

By applying serum creatinine criteria only, 20 patients (90.9%) experienced some form of AKI under the RIFLE scale. 2% were classified as risk, 22.7% were labeled as injury, and 27. Using the second set of criteria that include the serum creatinine level and urine output, 19 (86.4%) of the patients fulfilled the AKI criteria. Section 3: Distribution across RIFLE categories in this combined assessment was 22. This is supported by the hypothetical outcome of 8% failure, as shown in Tables 2 and 3.

Table 2: Distribution of AKI to serum creatinine according to RIFLE criteria only (N=22)

RIFLE criteria	**Serum Creatinine criteria only**	
	n	**%**
None	2	9.1%
Risk	4	18.2%
Injury	5	22.7%
Failure	6	27.3%
Any RIFLE category	5	22.7%
Total	22	100.0

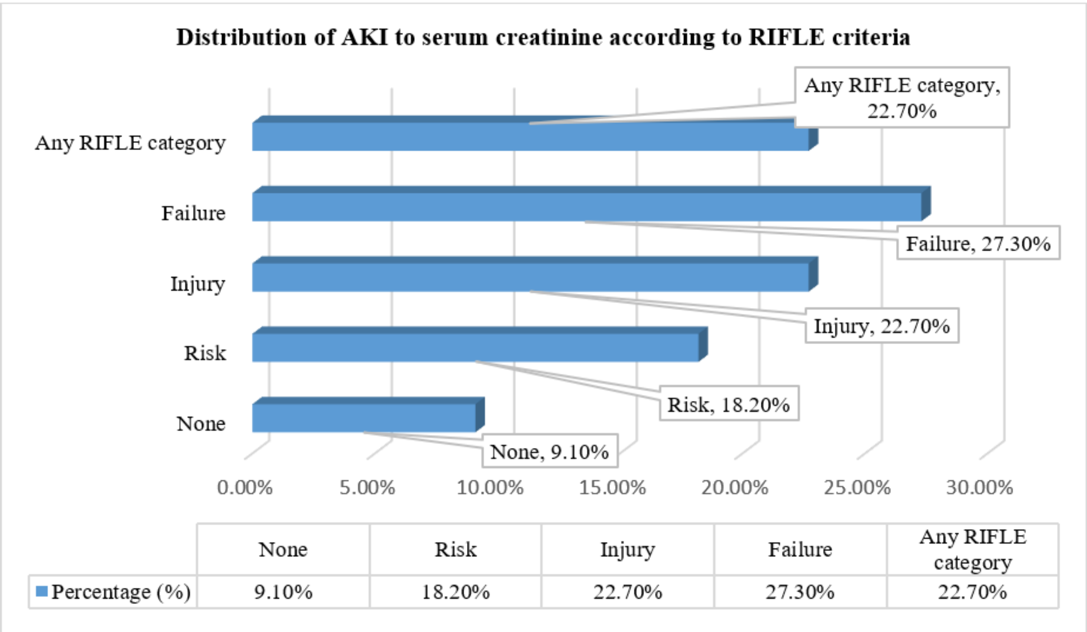

Figure III: Bar chart showed distribution of the patients by AKI to serum creatinine RIFLE criteria (N=22)

Table 3: Distribution of AKI: Worst criterion (both serum creatinine and urine output) (N=22)

RIFLE criteria	**Both**	
	n	**%**
None	3	13.6%
Risk	5	22.7%
Injury	4	18.2%
Failure	7	31.8%
Any RIELE category	3	13.6%
Total	22	100.0

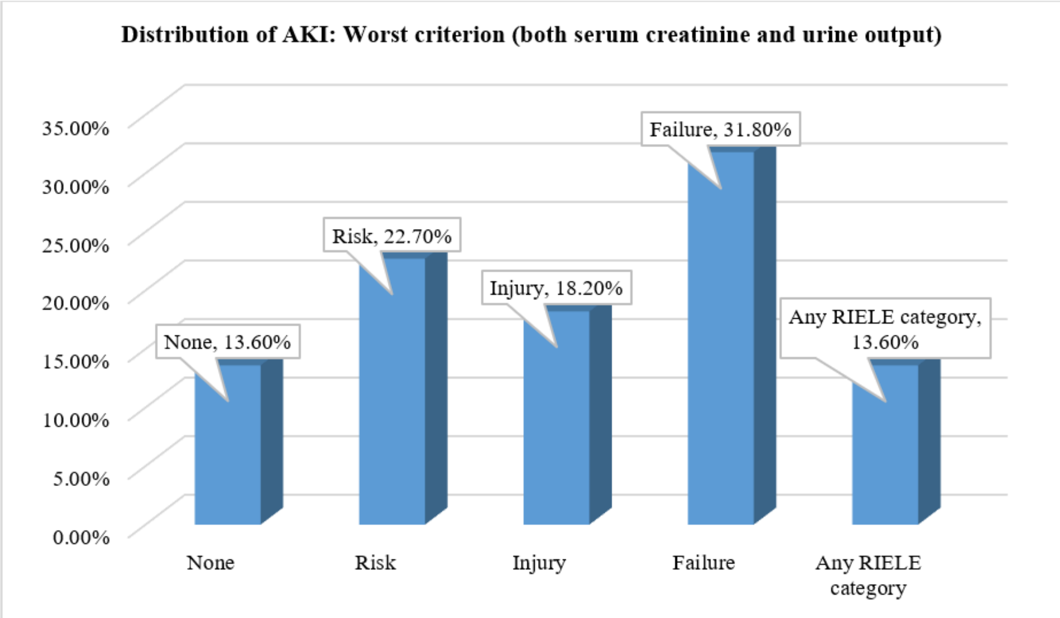

Figure IV: Bar chart showed distribution of the patients AKI: Worst criterion (both serum creatinine and urine output) (N=22)

We conducted an extended multinomial regression model of etiologic risk factors and found sepsis/septic shock to be associated with AKI incidence with an adjusted odds ratio of 2. 2 (95%CI 0. 8–5. 8); cardiac aetiology had a slightly lower but still significant AOR of 2. 7 (95%CI 1. 0–7.1). Though it is worth emphasizing that these relationships were not statistically significant, the reason may be the small number of respondents. AKI odds were significantly higher in patients with medical (OR 2. 49, 95CI 2. 34–2. 65) than surgical, neurological, and trauma (OR 1. 47, 95CI 1. 39–1. 55) etiologies (Table 4).

Table 4: Multivariate Predictors of AKI with Etiology(N=22)

Crude		**95% CI**	**P**		**Adjusted**	**95% CI**		**P**
		Lower	**Upper**	**value**	**OR**	**Lower**	**Upper**	**value**
Sepsis/Septic Shock	2.5	1.0	6.0	0.045	2.2	0.8	5.8	0.089
Surgical	1.8	0.7	4.8	0.202	1.5	0.5	4.5	0.313
Cardiac	3.0	1.2	7.5	0.018	2.7	1.0	7.1	0.053
Neurological	2.2	0.9	5.5	0.089	2.0	0.7	5.2	0.129
Trauma	1.6	0.6	4.3	0.273	1.4	0.5	4.0	0.341

It was revealing to look at the findings concerning comorbidities. Exacerbated respiratory disease has been identified as the comorbidity most significantly correlated with the development of AKI (OR = 3.56, 95% CI 0.33–38.78). This was done to determine the odds ratio of each factor, namely, hematologic malignancy (OR 4. 20, 95% CI 0. 40–43.82) and immunocompromised status (OR 2. 19, 95% CI 0. 32–15.04). Perhaps contrary to expectations, though still statistically significant, the CIs suggested lower odds of AKI in patients with hepatic disease (OR = 0.09, 95% CI = 0.01–0.70). Nonetheless, it is crucial to note that there is imprecision in these calculated odds ratios, as evidenced by the wider confidence intervals, especially where the study sample size was small (Tables 5 and 6).

Table 5: Distribution of patients according to comorbidity (n=22)

Co-morbid disease		Group I (n=9)	Group II (n=13)		OR	95% CI	P
	n	%	n	%			value
Cardio vascular							
Present	5	55.6%	7	53.8%	1.07	0.22-5.08	0.93
Absent	4	44.4%	6	46.2%			
Immunocompromised							
Present	7	77.8%	8	61.5%	2.19	0.31-15.68	0.43
Absent	2	22.2%	5	38.5%			
Respiratory							
Present	8	88.9%	9	69.2%	1.78	0.17-18.21	0.63
Absent	1	11.1%	4	30.8%			
Metastatic cancer							
Present	6	66.7%	10	76.9%	3.33	0.46-24.20	0.24
Absent	3	33.3%	3	23.1%			
Hepatic							
Present	3	33.3%	11	84.6%	1.82	0.26-12.82	0.54
Absent	6	66.7%	2	15.4%			
Hematologic malignancy							
Present	7	77.8%	12	92.3%	4.20	0.40-43.82	0.23
Absent	2	22.2%	1	7.7%			

Table 6: Multivariate predictors of AKI with comorbid disease (n=22)

Crude		95% CI P			Adjusted	95% CI P		
	OR	Lower	Upper	value	OR	Lower	Upper	Value
Cardio vascular	1.07	1.07	5.91	1.00	1.07	0.19	5.91	1.00
Immuno compromised	2.19	0.32	15.04	0.73	2.19	0.32	15.04	0.73
Respiratory	3.56	0.33	38.78	0.57	3.56	0.33	38.78	0.57
Metastatic cancer	0.60	0.09	3.99	0.96	0.60	0.09	3.99	0.96
Hepatic	0.09	0.01	0.70	0.04	0.09	0.01	0.70	0.04

Moreover, the description of comorbidities showed that 55% of patients had multiple chronic diseases. Patients in the AKI group (Group I) had a 6% CVD background, compared to 53% among patients in the CKD group (Group II). The incidence of AKI was significantly higher in the study group (Group I) than the non-AKI group (Group II) and was 8% in the non-AKI group. Being immunocompromised was more evident in the AKI group (778) than in the non-AKI group (615). Chronic respiratory conditions were observed in 88 percent of people. 9 AKI patients, compared to 69 percent of patients with other diseases. A non-significant difference was noted in the prevalence of metastatic cancer between the AKI group (66.7%) and the non-AKI group (76.9%). Surprisingly, the hepatic disease in the AKI group was less frequent than that in the non-AKI group (33.3% and 84.6%, respectively). A concomitant hematologic malignancy was detected in 77. also indicated that 8% of AKI patients and 92 were receiving RRT for AKI. There was a significant 48% reduction in the occurrence of death in AKI patients compared to the non-AKI patients, which was 3% (Table 5).

The study cohort was characterized by an impressively high prevalence of AKI (86.4%), which confirms the high risk of the development of this pathology in critically ill patients in the given population. In addition, it explains the high proportion of patients in the risk and injury categories (40.9%), the key area where early preventive measures should be implemented to avoid the further development of AKI. Sepsis and cardiac diagnosis accompanied AKI in 43% of cases, which underlines the necessity of careful sepsis and cardiac patients' treatment to address AKI risk. Although this investigation is based on a relatively small cohort and may not be generalizable to all critically ill populations, these findings help to elucidate current trends in AKI. It has been noted that care must be taken and continuous monitoring and interventions must be put in place, especially in patients with certain underlying diseases or conditions such as sepsis or cardiac issues. The findings also emphasized the significance of risk and injury as a critical phase for timely intervention to prevent the condition from escalating further to AKI.

DISCUSSION

The findings of this small-scale prospective cross-sectional study present valuable information on the incidence and possible predictors of AKI in critically ill patients in Bangladesh. Some of the main discovery points are: The AKI rate is at a significantly high level (86.4%), with the most revealing factors being sepsis and cardiac etiology. Chronic comorbidities, including prior lung disease, dia, hematologic cancer, and immunosuppressed states, were the following risks for

AKI, though confidence intervals were imprecise. In the study, they recorded an 86% AKI incidence rate among their patients. 4% is significantly higher than the prevalence rates highlighted in most Western-centric investigations, which stand at between 20 and 50% [13]. Another extensive study conducted in with a cohort of participants from multiple countries identified the incidence of AKI to be approximately 5% [14]. The third study, for example, found a prevalence rate of 7% among ICU patients, but this study had a more stringent definition of the condition. One study highlighted the incidence of AKI, as noted in 39 [13]. In the article, it was identified that 3% of critically ill patients required limb amputation. The higher rate in our cohort may suggest some variability in patient demographics, rationale for ICU admission in Bangladesh, or profile of risk factors in the study population [14]. It also brings out a concern about how much AKI affects incorporated systems in low-resource intensive care units. Our findings agreed with previous research published on this topic, where sepsis appeared as the leading risk factor for AKI [15]. In patients with AKI, [11]. Identified that septic shock had an increased risk, with a two-times risk of developing AKI compared to non-septic patients. The process involves inflammation of the kidney, abnormalities of microcirculation, and direct toxin-induced renal tubular injury. It would be important to note that the early identification and management of sepsis can help prevent the onset of AKI. The second strongly correlated factor identified in our study was clock-related cardiac etiology. This is in concordance with findings made in the Waikar study, where sources indicated that AKI risk was higher among patients who underwent cardiac surgery. Preeclampsia could be mediated by cardiorenal interactions related to hemodynamics, neurohormonal activation, and inflammatory processes [16]. To prevent the occurrence of contrast-induced nephropathy, enhancing cardiac function and avoiding the use of nephrotoxic contrast agents are the best preventive methods. Of the comorbidities included in the analysis, the presence of preexisting respiratory disease was most closely associated with AKI. Unlike in some earlier pieces of research, where chronic kidney disease was the dominant risk factor, Recent studies have shown that there are interactions between the lung and kidney in the pathophysiology of AKI; these include hypoxia, inflammation, and hemodynamic changes [17]. Several interventions aimed at optimizing lung protective ventilation could be helpful in decreasing the AKI risk amongst these patients. Previous studies have reported that an immunocompromised state is a risk factor for AKI. Immune suppression enhances the risk of sepsis and may limit the ability to recover renal function [7]. In their study, [10] reported an adjusted odds ratio of 1.38 for AKI in immunocompromised patients. Because of this, issues of fluid and electrolyte balance and the avoidance of nephrotoxic agents are particularly important in this population. Notably, in our study, we observed a negative correlation between hepatic diseases and the risk of AKI. This is contrary to some studies where the incidence of AKI among cirrhotic patients has been reported to have risen. This may be a result of the sample size or could be Because of the differences in the severity of the liver disease among the patients in the current study, Further, larger trials are required to better determine the appearance of hepatic dysfunction and the subsequent risk for AKI in critically ill patients [18]. The majority of our cohort encompasses risk and injury categories and has the potential to be at risk of early intervention. Perhaps using electronic alert systems to identify these patients and implementing nephroprotective measures could avert such progression to worse AKI. This includes management of hemodynamics, choice of medications, absence of nephrotoxic drugs, and appropriate use of fluids. Demographically, the study population is characterized differently than Western cohorts by a lower mean age of 42 years [5]. This may be due to the population characteristics in Bangladesh and can be used to reinforce that AKI does not exclusively affect elderly patients in this context. This gender difference in AKI incidence also goes against some literature and calls for further research into possible gender disparities regarding the risk factors for AKI or the management of the condition. Our study has several strengths based on the following factors: the prospective design of the study, the standardized application of the RIFLE criteria, and the assessment of the impact of multiple comorbidities. Some of the potential biases include a small number of patients, a study conducted in a single center, and no follow-up data in the long term [12]. The observational character hinders the ability to determine cause and effect for the detected relationships.

The given findings are important for understanding clinical practice and research in Bangladesh and other comparable settings. Hence, AKI remains remarkably prevalent in critical care settings, justifying the need for early identification and prevention initiatives in the ICU. Sepsis, cardiac pathology, pulmonary disease, and immunocompromised patients are likely to develop AKI, and they should be monitored closely. Therefore, it is necessary to apply the electronic alert systems, which are based on RIFLE criteria, to enhance early identification and intervention. The author asserts that management protocols should target early and vigorous sepsis management, probable optimal heart function, protective ventilation, and prohibited toxins in high-risk patients [18]. Therefore, future studies should aim to identify and validate other comorbidities that might be more strongly associated with AKI using a larger sample size, preferably multicenter studies, to quantify the true incremental risk of the various comorbidities and assess the impact of prevention strategies. Nevertheless, owing to these drawbacks of serum creatinine in the acute context, a desperate search for early biomarkers of AKI is valid. However, data on renal recovery and outcomes in chronic kidney disease among survivors of AKI are lacking, and long-term follow-up studies are required. All the aforementioned recommendations should inform a strategy to enhance AKI management, decrease its occurrence, and increase survival among the critically ill in low-resource environments.

In summary, this research has provided insight into the high prevalence of AKI in critically ill patients in the Bangladeshi context and has presented potential risk factors that can inform interdisciplinary interventions to address the problem. Therefore, more emphasis should be placed on awareness, early diagnosis initiatives, and specific measures in order to minimize the effects of this particular complication. Further observational studies, including a greater number of centers, are needed to explore the relationship of comorbidities to AKI in the LMICs.

CONCLUSIONS

The current cross-sectional study identified AKI in 86.4% of ICU patients admitted to a hospital in Bangladesh. Sepsis, cardiac dysfunction, respiratory disease, and immunosuppression can be identified as concerning risk factors. Their high prevalence in the early stages also presents a potential for targeted measures. More extensive investigations in a number of centers are required to more accurately characterize risk and assess the efficacy of preventative interventions in this context.

Conflict of interest: Author stated that there were no conflicting interest.

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